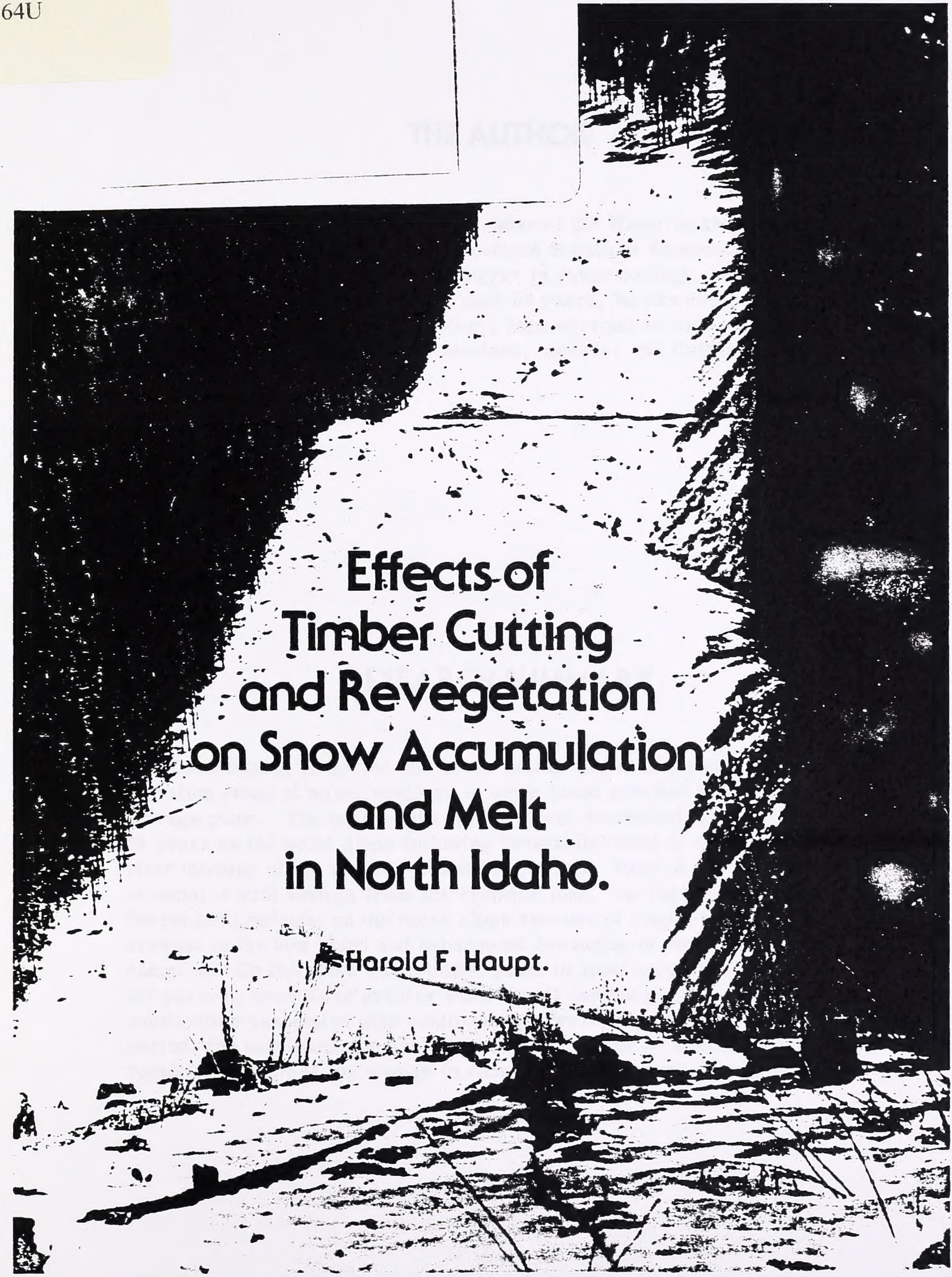
Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

XEROX COPY DO NOT REMOVE

A99.9 F764U

R5



Effects of Timber Cutting and Revegetation on Snow Accumulation and Melt in North Idaho.

Harold F. Haupt.

USDA FOREST SERVICE RESEARCH PAPER INT-224
INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION
FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE

THE AUTHOR

HAROLD F. HAUPT is the former leader of the Water Quality Management research work unit of the Intermountain Station at Moscow. He holds a B.S. degree in forestry and M.S. degree in range ecology, both obtained at the University of Idaho. For the past 29 years, he has conducted research in the fields of snowmelt hydrology, logging-road erosion, soil stabilization, and water quality in Idaho, Montana, Nevada, and California.

RESEARCH SUMMARY

Clearcutting on north- and south-facing slopes in a young mature, mid-elevation stand of mixed conifers in north Idaho resulted in substantial snow storage gains. The initial gain of 56 percent decreased to 37 percent after 34 years on the north slope following reestablishment of a new stand and later thinning of the 26-year-old sapling stand. Most of the increase was associated with savings from interception loss. Spring snowmelt rates also decreased gradually on the north slope because of crown-cover density increases in the new stand and subsequent expansion of shade cast by the canopies. On the south slope initial gains in snow accumulation were less (37 percent) because of greater winter melt and the greater evaporation/sublimation associated with south-facing clearcuts. In the 34-year study period, the new stand reestablished slowly because of brush competition, resulting in little if any change in snow accumulation gains or melt rates.

USDA Forest Service
Research Paper INT-224
June 1979

Effects of Timber Cutting and Revegetation on Snow Accumulation and Melt in North Idaho.

Harold F. Haupt.

INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION
Forest Service
U.S. Department of Agriculture
Ogden, Utah 84401

CONTENTS

Page

INTRODUCTION 1

SILVICULTURAL HISTORY 2

PHYSICAL ENVIRONMENT. 4

METHODS 4

PEAK SNOW ACCUMULATION 5

Harvesting Effect 5
Climatic and Vegetative-Recovery Trends 8

SPRING SNOWMELT RATE 12

North Slope. 12
South Slope 12

SUMMARY AND CONCLUSIONS 13

PUBLICATIONS CITED 14

INTRODUCTION

The mixed-species conifer forests of north Idaho, northeastern Washington, and western Montana represent the highest major water-producing zone in the interior West. Precipitation amounts are high, ranging from 30 to 80 in (76 to 203 cm), with more than one-half accumulating in a snowpack from November through April. The removal of tree cover by clearcutting in patches, strips, or blocks greatly accelerates the winter storage of snow and thus increases the amount of water available to streamflow.

Augmentation of water yield represents a desirable goal of timber harvest but must be carefully controlled to avoid adverse effects on water quality and channel stability. To accomplish this goal, Forest Service hydrologists emphasize water quality as timber sales are designed, stressing that harvesting in a given watershed must proceed gradually to prevent an imbalance in the streamflow regime. Additionally, when reentering a partially logged watershed, the reduction of water yield with vegetative recovery must be evaluated before deciding on how much new timber will be harvested (USDA Forest Service 1973). Hydrologists in this region presently have very little documented evidence on the rise and fall of water yield as a timber stand is cut and subsequently revegetated.

Increases in water yield are generally proportional to the reduction in forest canopy, as well as to the intensity of partial cutting or percentage of clearcut area (Stone 1973). The duration of the yield increase depends on how rapidly roots reoccupy the soil and how quickly the canopy is reestablished. Canopy reestablishment directly affects snow accumulation.

Generally, research shows that gains in snow accumulation can be expected to persist longer than gains in soil water (Anderson 1969). Increased snow accumulation in lodgepole pine in the central Rocky Mountains will apparently persist for many decades and perhaps indefinitely (Gary, in press). In California, soil water gains on level terrain were negligible 16 to 20 years after clearcutting (Zeimer 1964).

In a recent study in north Idaho, soil water gains on a steep south-slope clearcut disappeared within 4 years after the climax understory brush reoccupied the area (Cline and others 1977). In the same study, soil water increases were present for at least 5 years on a north-slope clearcut because herbaceous plants reinvaded and dominated the clearcut early in the recovery period, although the deeper-rooted brush was making rapid inroads by the fifth year. By extrapolation of the data, it would appear that the north-slope soil water gains would approach zero earlier than the 16 to 20 years observed in the California study. In contrast, on both the north and south clearcuts no downward trend in snow accumulation gains was evident 5 years after harvest (Cline and others 1977).

This paper reports changes in snow accumulation gains on another site clearcut 34 years ago in the same general area. A paired-plot comparison was made between the clearcut and an adjacent stand of mature timber. Records were obtained periodically beginning with the second year and ending with the 34th year after harvest.

SILVICULTURAL HISTORY

The study site was located in the Benton Creek drainage of the Priest River Experimental Forest (PREF). In 1940 a strip clearcut, 330 ft (101 m) wide was extended from the ridge on the south side of Benton Creek and up the opposite slope to the ridge on the north side of Benton Creek (fig. 1 & 2). The clearcut was harvested with a conventional "jammer" cable system; slash from the cutting operation was hand piled and burned.

Original timber on the north slope consisted of young mature western redcedar (*Thuja plicata* Donn), western hemlock (*Tsuga heterophylla* [Raf.] Sarg.), western white pine (*Pinus monticola* Dougl.), grand fir (*Abies grandis* [Dougl.] Forbes), and western larch (*Larix occidentalis* Nutt.). The south slope was stocked with young mature timber of three species--ponderosa pine (*Pinus ponderosa* Laws.), Douglas-fir (*Psuedotsuga menziesii* var. *glauca* [Beissn.] Franco), and western white pine.

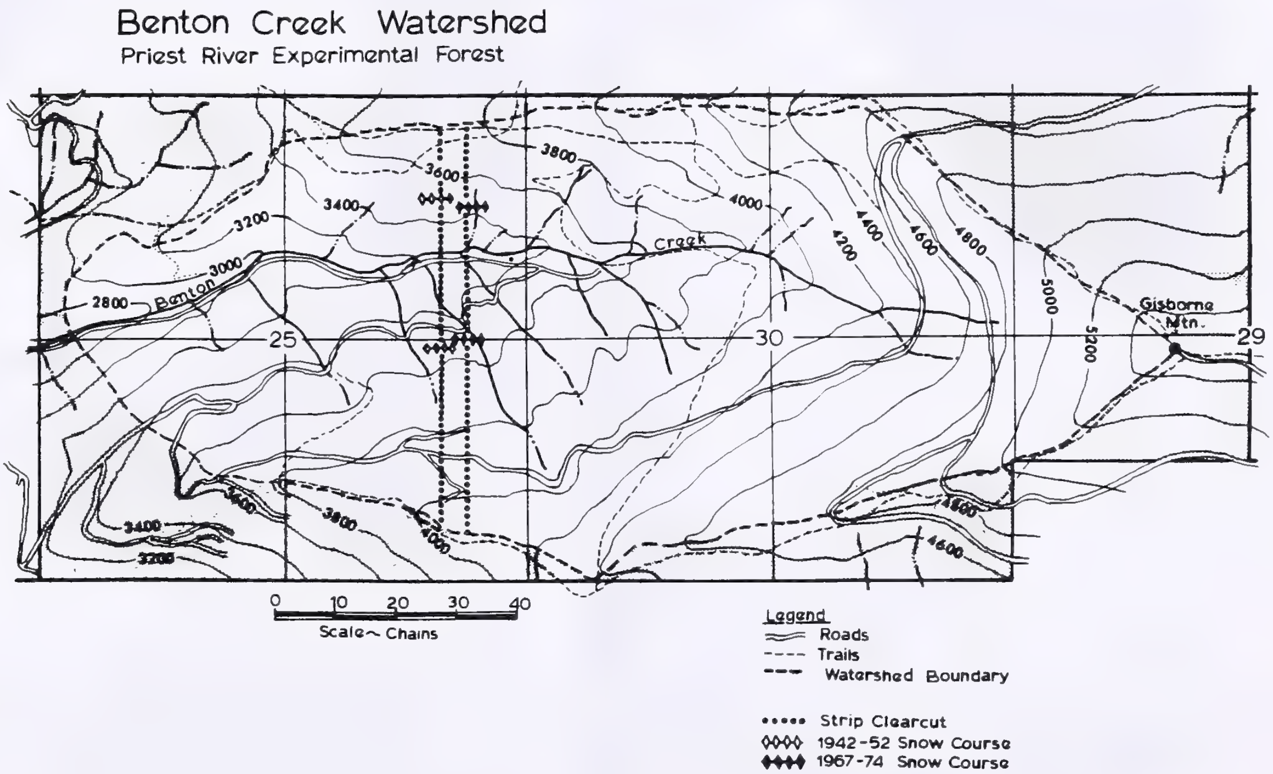
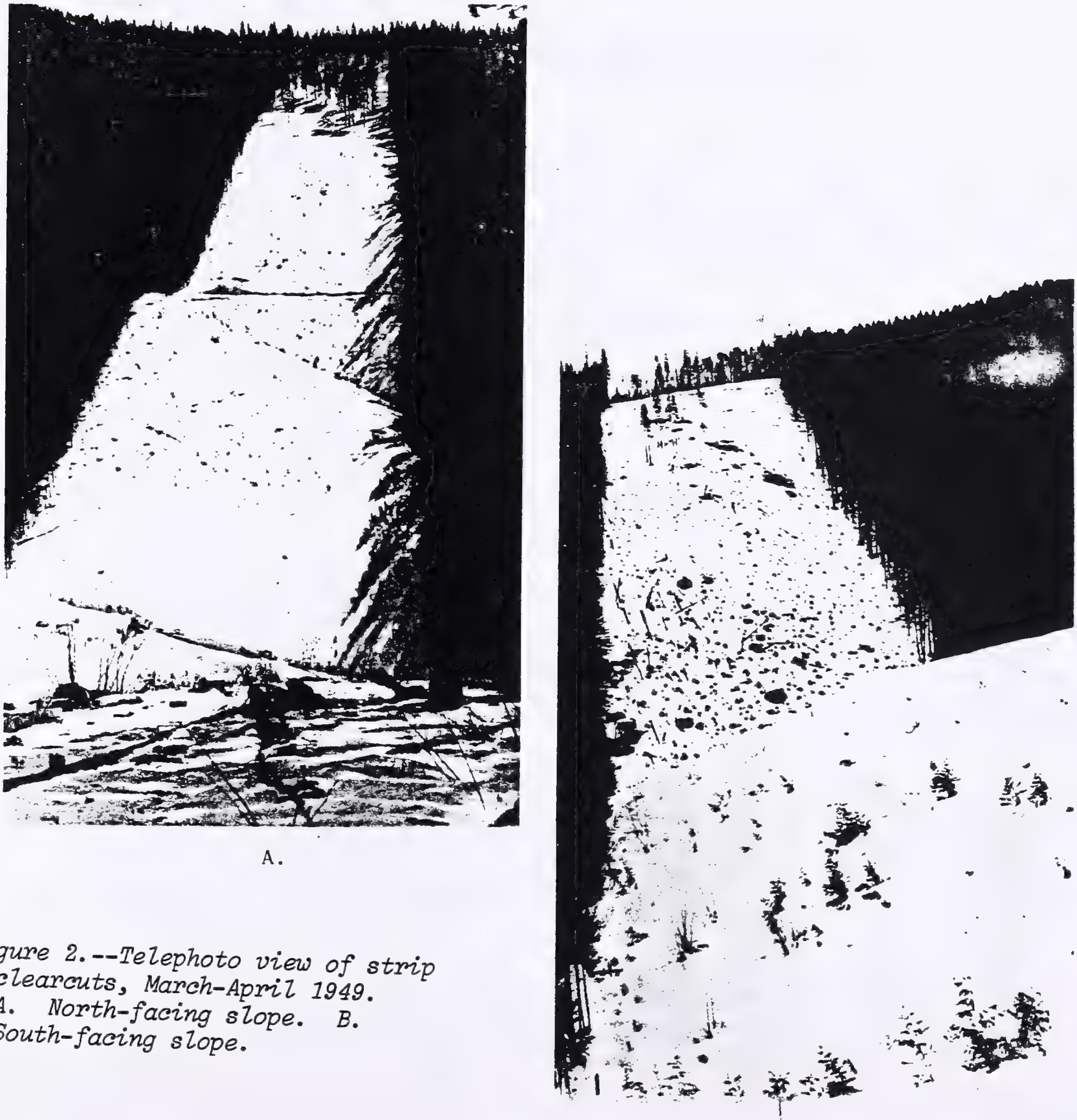


Figure 1.--Benton Creek watershed, Priest River Experimental Forest.

---

[1] Graham, R. T. 1976. Silvicultural prescription, stand 20-1-24, Priest River Experimental Forest, Idaho Panhandle National Forests. Unpubl. rep., on file at Forestry Sciences Lab., Intermt. For. and Range Exp. Stn., Moscow, Idaho.

Natural reproduction on the north-slope strip clearcut, hereafter referred to as the "vegetative recovery plot," was well established by 1945. A species survey 20 years later showed 3,320 stems per acre, consisting of 60 percent western redcedar and 20 percent western hemlock. Heights of most saplings ranged from 10 ft (3 m) to over 15 ft (4.6 m). The south face quickly brushed over and as a consequence, the present stand is poorly to fairly well stocked with stems of the three original species (fig. 3).



A.

B.

Figure 2.--Telephoto view of strip clearcuts, March-April 1949. A. North-facing slope. B. South-facing slope.

A 1967 thinning operation on the north slope showed grand fir, western redcedar, western larch, and western hemlock favored at 200, 400, and 800 trees per acre. The snow-sample study conducted on the vegetative recovery plot favored western redcedar at 400 trees per acre or an average spacing interval of 10x10 ft (3x3 m). The silvicultural prescription calls for thinnings in 1985, 2005, and 2025, with the final harvest in 2045.[1] No silvicultural treatment is planned for the south slope.

PHYSICAL ENVIRONMENT

The climate of the Experimental Forest is predominantly under the influence of the Pacific Ocean. Winter storms bring most of the annual precipitation in the form of snow. At the plot elevation (3,500 ft or 1,067 m), the estimated average annual precipitation was 33 to 36 in (84 to 91 cm). At this elevation, thaws are common throughout the winter; hence, the peak snow water equivalents measured from March 1 to April 1 underestimate the total winter snowfall.

Slope gradients on the north slope average 52 percent; on the opposite slope, 58 percent. For information on geomorphology and soils and complete data of the biological environment, the reader is referred to R. T. Graham's report.[1]

METHODS

In 1942 snow courses were established on the west half of the vegetative recovery plot and extended into an adjoining forest plot (fig 1). Snow depth and snow water equivalents (W.E.) were initially taken with a Mt. Rose snow tube and. later, with a federal-type snow sampler. Measurements began at approximately the time of maximum accumulation and continued about weekly through the melt period. This was repeated for 13 seasons on the north slope and 6 seasons on the south slope from 1942 through 1974.

The spacing and number of sample points and the location of snow courses changed during the study period as a result of amendments to the original study objectives (table 1). In 1967, the earlier courses were switched to the opposite side of the vegetative recovery plot (fig. 1). Because of expected differences in snow conditions between the east and west recovery-forest boundaries, measurements taken in the vicinity of the border zone were eliminated from the analyses. Data from the sample points for each year were averaged.

Table 1.--*Snow course stations (number and approximate spacing in feet)*

	North-face		South-face	
Year	Strip clearcut	Timber	Strip clearcut	Timber
1942	5-30	5-30	5-30	5-30
1949-52	9-20	6-20	8-20	7-20
1967-73	3-50	2-50		
1974	3-50	2-50	3-50	2-50

The structure of timber on the forest control plot was assumed to have changed over the 34-year evaluation period. To test this assumption, a time-trend analysis was performed, including climatic data recorded at the PREF headquarters station (elevation 2,380 ft [725 m]). Data for the vegetative recovery plot were similarly analyzed to determine if vegetation had recovered enough to have affected snow accumulation and melt. In other tests, water-equivalent changes in the snowpack over time were compared using regression techniques.

PEAK SNOW ACCUMULATION

Harvesting Effect

On the north slope, the removal of the young mature timber resulted in average snow W.E. gains in the vegetative recovery plot of 7.6 in (19.3 cm) for the period 1942 through 1952 (table 2). This was the period of early stand reestablishment and development (fig. 2). The average yearly gains compare favorably with those of 6.6 in (16.8 cm) measured in a narrower strip (200 ft [61 m]) cut in mature-overmature cedar-hemlock-white pine 1,000 ft (305 m) higher in elevation (Haupt, in press). Most of the snow accumulation increase was the result of snow caught in dense canopies that would have evaporated/sublimated had the trees not been harvested. Another portion of the increase was probably the result of wind eddy-forest edge effect during storms, and a fractional increase was perhaps due to slower winter release of water from the snowpack in the opening compared with the forest (Haupt 1972, in press). Gains on the recovery plot are shown in figure 4.

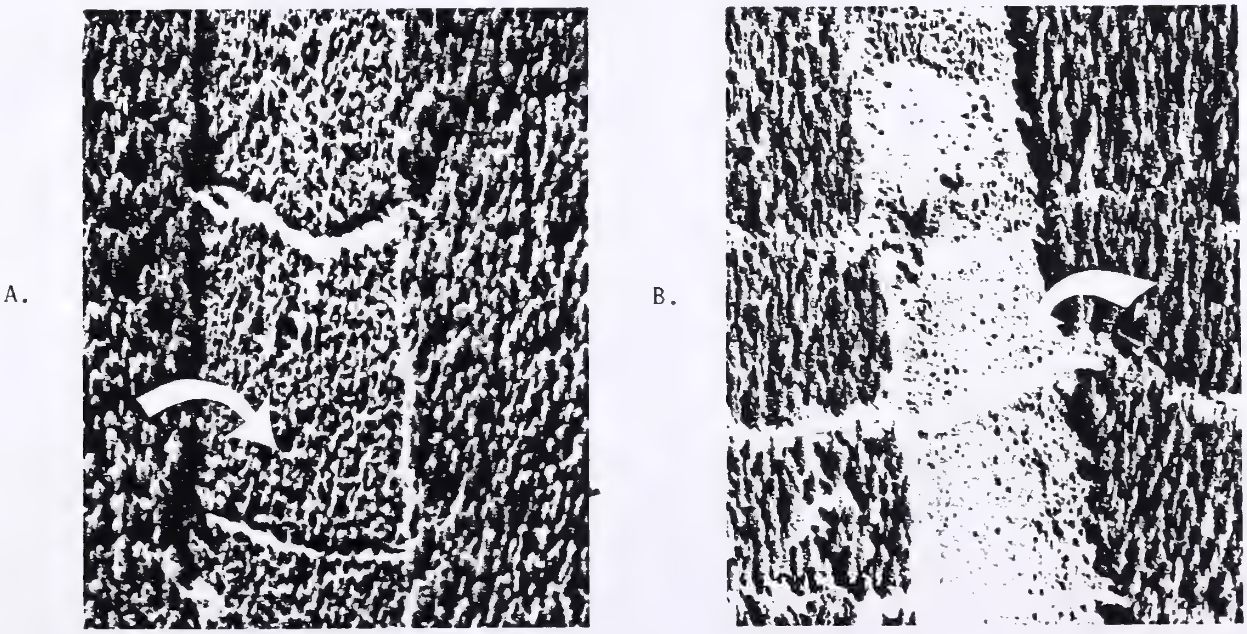


Figure 3.--Aerial view of strip clearcut taken May 1966 (arrows denote study plots). A. North-facing slope before thinning. B. South-facing slope.

Table 2.--*Average peak snow water equivalents, gross melt, and average melt rate/day by plot condition-slope aspect-year*

Year	Peak snow accumulation				Spring snowmelt					
					Gross			Rate/day		
	Date	Forest plot	Recovery plot	Gains on recovery plot	Date of snow disappearance on forest plot (north slope) and recovery plot (south slope)	Forest plot	Recovery plot	Days until disappearance on forest plot	Forest plot	Recovery plot
		Inches	Inches	Inches		Inches	Inches		Inches	Inches
					NORTH SLOPE					
1942	3/30	3.5	10.8	7.3	4/6	3.5	6.1	11	0.32	0.55
49	3/30	11.5	22.1	10.6	4/30	11.5	18.6	32	.36	.58
50	3/31	12.2	19.5	7.3	5/16	12.2	18.3	47	.26	.39
51	3/27	6.6	13.2	6.6	4/18	6.6	8.3	23	.29	.36
52	3/31	12.2	18.4	6.2	4/27	12.2	16.8	28	.44	.60
1967	4/4	4.4	13.0	8.6	5/9	4.4	5.1	36	.12	.14
68	3/19	1.4	7.8	6.4	3/28	1.4	0.1	10	.14	.01
69	3/28	14.6	17.7	3.1	5/3	14.6	11.8	37	.39	.32
70	3/26	11.2	15.5	4.3	5/7	11.2	10.0	43	.26	.23
71	4/12	6.4	12.5	6.1	5/2	6.4	8.3	21	.30	.40
72	4/3	2.0	7.4	5.4	4/29	2.0	1.9	27	.07	.07
73	3/19	1.1	5.2	4.1	4/2	1.1	0.5	15	.07	.03
74	4/2	9.0	14.0	5.0	4/30	9.0	9.0	29	.31	.31
					SOUTH SLOPE					
1942	3/4	4.4	5.8	1.4	3/20	3.6	5.8	17	.21	.34
49	3/1	7.9	10.9	3.0	4/6	7.0	10.9	37	.19	.29
50	3/10	8.0	11.9	4.0	4/19	6.9	11.9	41	.17	.29
51	3/15	3.6	6.3	2.7	4/4	3.3	6.3	21	.16	.30
52	3/10	8.8	12.6	3.8	4/12	7.1	12.6	34	.21	.37
1974	3/21	2.7	6.4	3.7	4/2	2.7	5.7	13	.21	.44

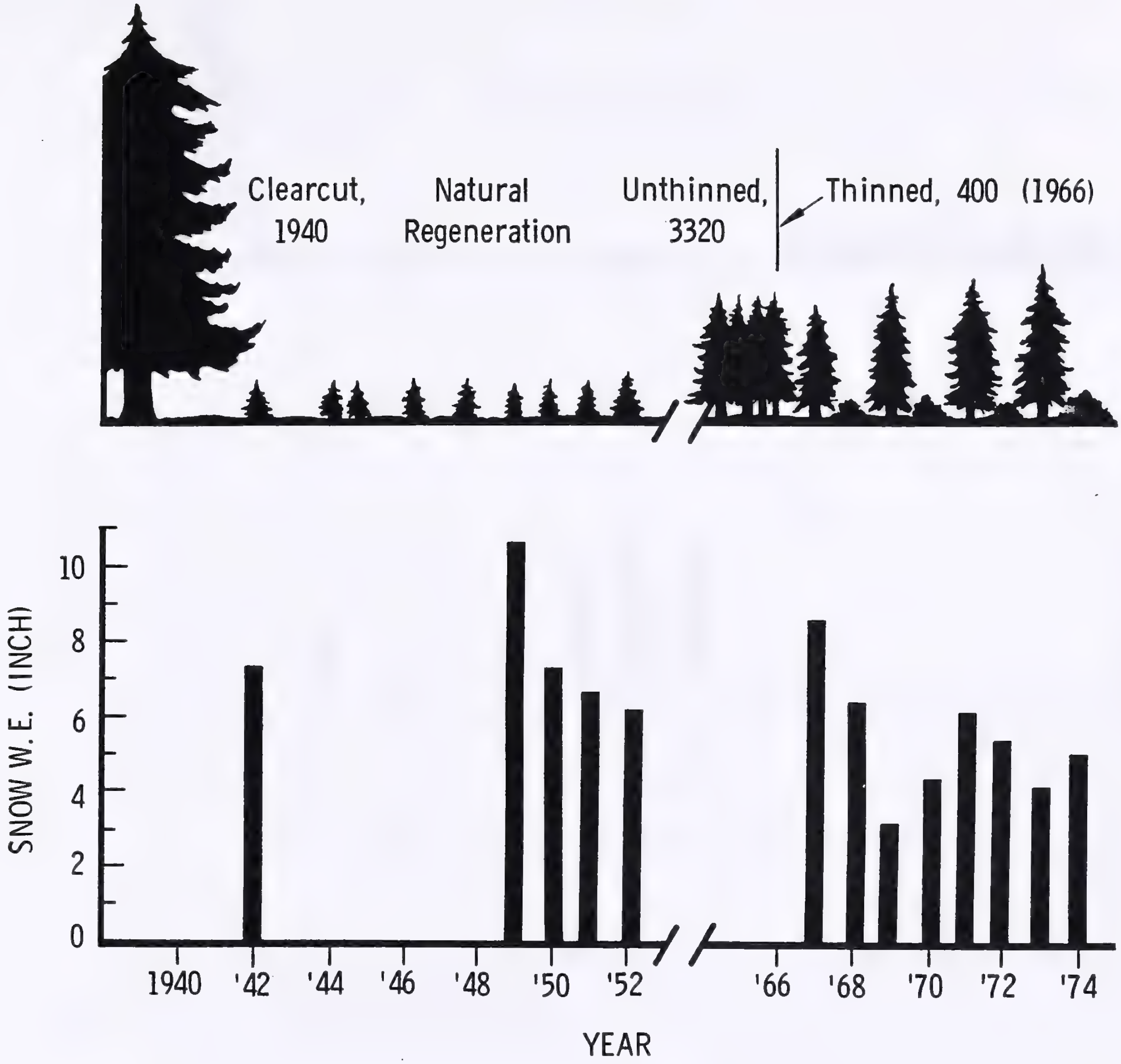


Figure 4.--Snow W.E. gains on recovery plot, north slope.

Water equivalent gains on the south slope recovery plot (fig. 3) averaged a yearly increase of 3.0 in (76 cm)--only 39 percent of that on the opposite slope (table 2). The measured gain in 1974 was slightly greater on the south-slope plot than the average for 1942 through 1952 (fig. 5). These plot gains are about twice those observed at a higher-elevation clearcut of similar size, shape, and slope, though with greater exposure to wind and energy input (Haupt, in press).

Physical processes are more severe on the south slope than on the north. However, a porous, less dense tree cover does allow more snowfall to filter through to the ground, and, in addition, sustained wind, often very gusty, tends to blow snow off the canopy and onto the ground below. As a consequence, less canopy-held snow is evaporated/sublimated.

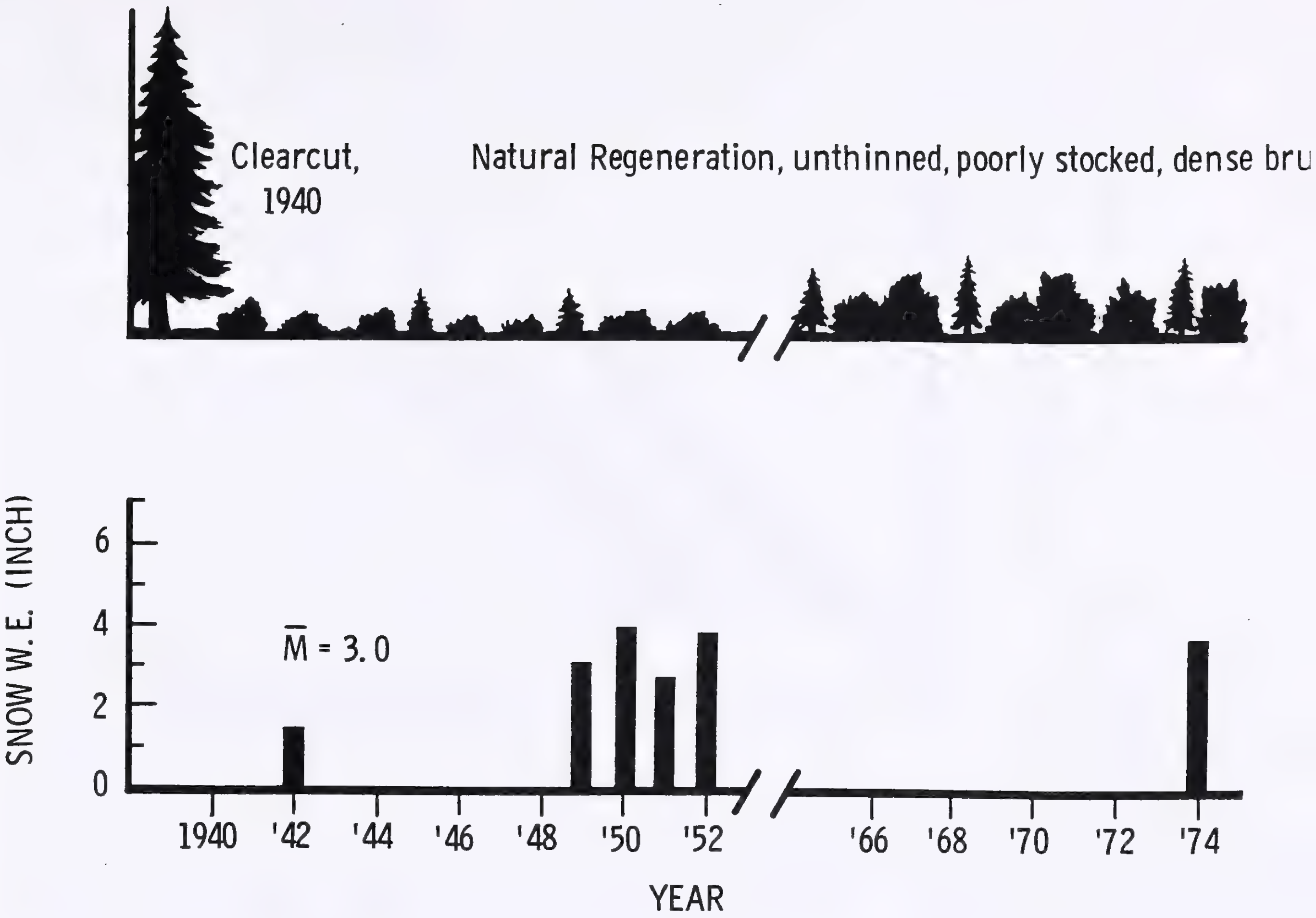


Figure 5.--Snow W.E. gains on recovery plot, south slope.

Once timber is cleared, the south slope opening presents an even more hostile environment for conserving snow. Subjected to considerable wind scouring, increased winter melting, and greater surface evaporation/sublimation, the clearing registers a smaller net increase in snow W.E. than a comparable opening on a north slope.

Climatic and Vegetative-Recovery Trends

On the north slope a greater depth of snow W.E. was measured in the recovery plot during the 1942 to 1952 period than in the interval from 1967 to 1974 (fig. 6). The levels or intercepts of the two regressions are significantly different ($P<=0.04$). This may be interpreted as a time-dependent decrease in snow W.E. gains. The curves lie well above the "100 percent recovery" line, a theoretical point in time when the structure of the timber on the recovery plot approximates that of the surrounding forest.

The apparent downward trend was tested by adjusting for year-to-year variations in winter precipitation and mean winter temperature (measured at headquarters station). Results of the test after including a time-trend variable are presented in table 3.

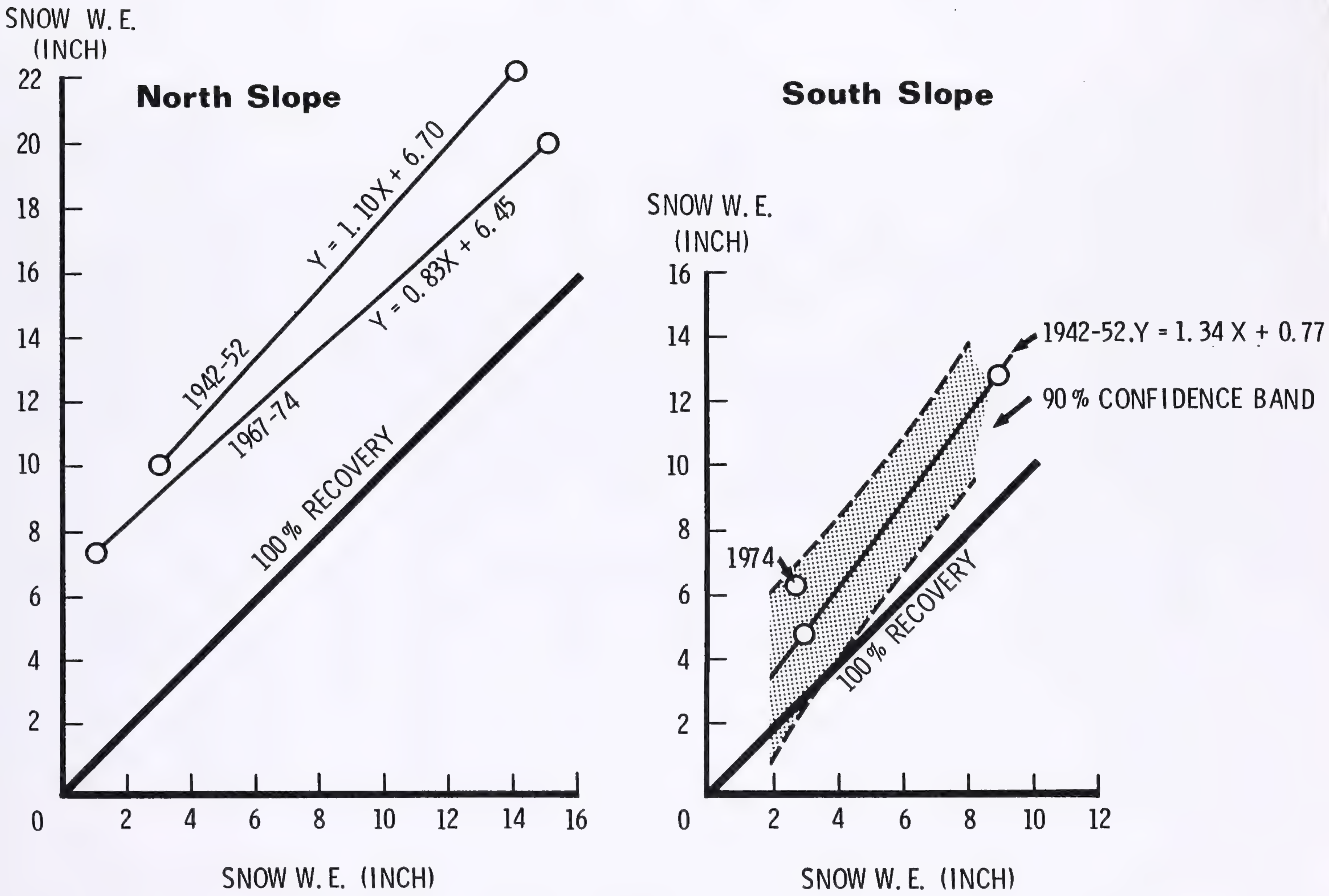


Figure 6.--Recovery-forest plot comparisons of peak snow accumulation on north and south slopes.

Table 3.--*Time trend analyses by step-wise regression, north slope*

Snow characteristic/ plot	Variable	B value	R^2	F	Probability F
Peak snow accumulation					
Forest	Intercept	39.1890	0.534		
	Winter temperature[1]	-1.3382		6.20	0.03
	Winter precipitation[2]	0.3709		3.11	0.11
	Time trend[3]	-0.0405		0.16	0.70←rejected
Recovery	Intercept	47.4722	0.717		
	Winter temperature	-1.3828		9.44	0.01
	Winter precipitation	0.4521		6.60	0.03
	Time trend	-0.1512		3.19	0.11
Spring snowmelt rate					
Forest	Intercept	-1.2085	0.654		
	Spring temperature[4]	0.0353		11.77	0.01
	Time trend	-0.0016		0.50	0.50←rejected
Recovery	Intercept	-1.7558	0.874		
	Spring temperature	0.0527		25.27	0.001
	Time trend	-0.0078		11.68	0.01

[1] Mean daily temperature for 5 months, November through March.

[2] Total precipitation for 5 months, November through March.

[3] Increasing numerical value with years since 1940 harvesting (i.e., 1941--1, 1974--34).

[4] Mean daily temperature for period beginning on day of peak snow accumulation and ending with day of snow disappearance on forest plot.

For the forest plot, the winter temperature coefficient was negative, indicating a reduction in peak W.E. associated with warm, thawing winters. The time-trend variable was unimportant, suggesting that change in the structure of the unmanaged forest from young mature to mature over 34 years of record had no detectable effect on peak snow accumulation.

On the recovery plot, the two climatic variables responded in the same manner (table 3). However, the negative time-trend coefficient was accepted as important ($P<=0.11$). Apparently the managed, sapling stand was effecting a gradual reduction in peak W.E. unexplained by winter temperature or precipitation input. The gradual decline resulted probably from increases in interception loss associated with the expanding canopies and slightly greater winter release of water from the snowpack. An earlier study conducted near the headquarters station revealed that individually weighed sapling trees (Douglas-fir and western white pine) will lose by evaporation to the atmosphere 4 to 5 percent of the total snowfall (Satterlund and Haupt 1970).

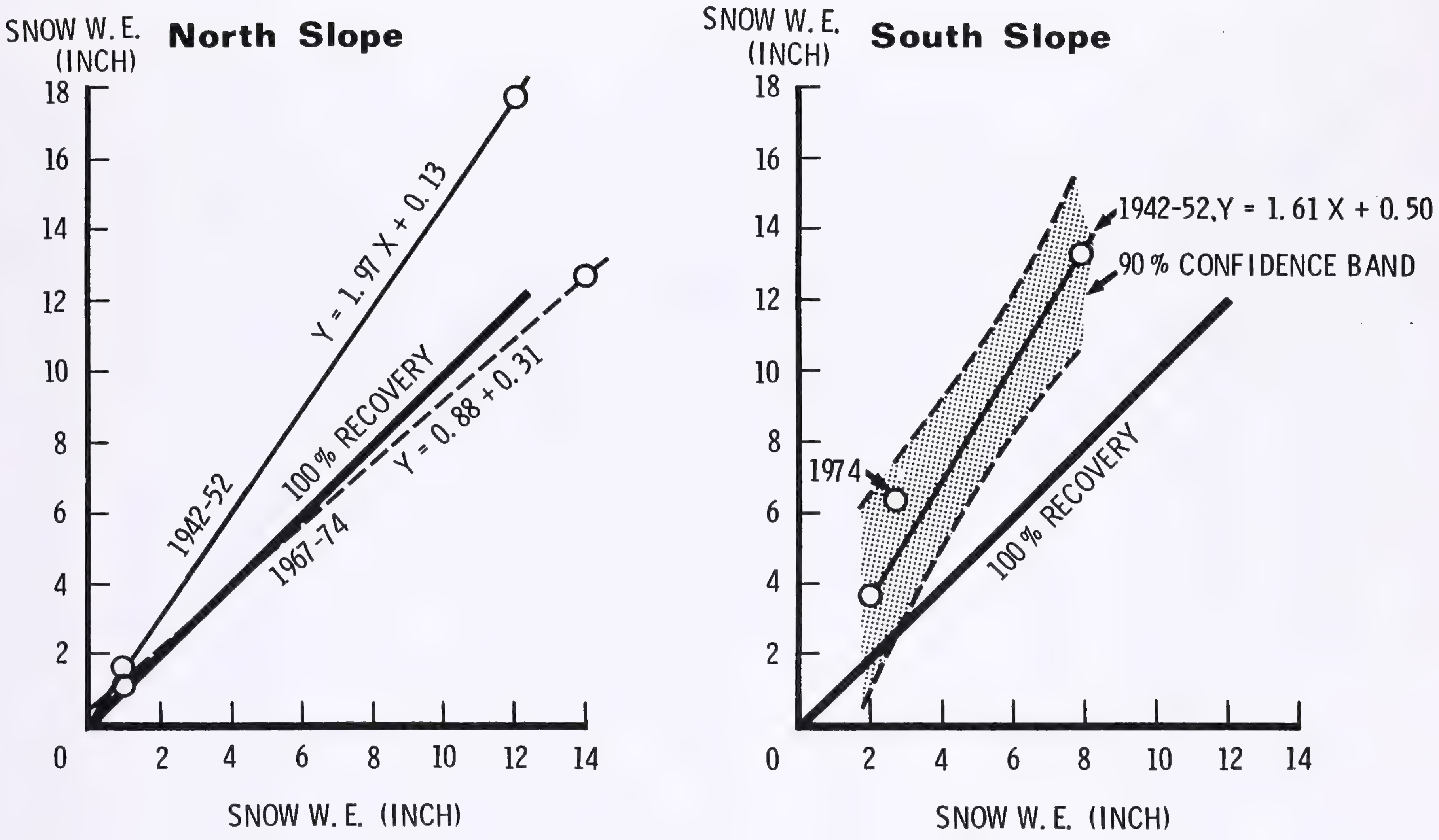


Figure 7.--Recovery-forest plot comparisons of spring snowmelt on north and south slopes.

Under south-slope conditions, as shown in figure 6, the positive slope coefficient (>1.00) denotes greater differences between forest and recovery plots in winters with heavy snowfall.

Was there a trend on the south-slope recovery plot? The measurement taken in 1974 lies within the 90 percent confidence band that was calculated based upon the variance about the individual value. Apparent lack of trend, if indeed this was the case, was not unexpected since the reestablishment of the new stand was progressing slowly. There were less than 100 trees per acre (<40 trees/ha) on the recovery plot.

SPRING SNOWMELT RATE

North Slope

Spring snowmelt rates were determined for the recovery plot by dividing the accumulated snowmelt--up to the time snow *disappeared* on the forest plot--by the number of days elapsed. For the forest plot, total snowmelt equaled the value shown for the peak W.E. Average rates by year are listed in table 2.

The regression curves (fig. 7) show much faster snowmelt on the recovery plot from 1942 to 1952 than from 1967 to 1974. The suggested downward trend was supported by results of the time-trend analyses (table 3). We expected the spring temperature coefficient to be positive and highly correlated with snowmelt. Again, the time-trend variable under forest conditions was unimportant. In the 34-year period, changes in melt rate were apparently associated only with deviations in spring temperature.

For the recovery plot, the analysis revealed a highly significant negative time-trend coefficient ($P<=0.01$). The occurrence of slight gradual decreases in snowmelt rate in recent years was entirely independent of temperature rise and fall. The thinned sapling stand--growing taller and enlarging its crown area each year--was apparently acting as a barrier to wind movement and was casting an ever-expanding shadow to shade the snowpack, thus effecting a gradual reduction in average melt rate.

Of special interest in figure 7, the 1967 to 1974 regression curve is plotted slightly *beneath* the 100-percent recovery line. After 34 years, the managed, sapling stand had recovered with melt rates equal to or slightly reduced from those associated with the residual mature timber. Crown-cover density in 1974 was estimated to be 0.22, compared with the mature forest figure of 0.80. Similar relations between crown-cover density and snowmelt on the north slope were reported by Packer (1971). The rate of snowmelt at his site *decreased* as crown-cover density *increased* from zero to 0.25, but then *increased* from 0.25 to 1.00. Experimentation conducted in the central Sierra Nevada with radiation instruments supports Packer's empirical results (U.S. Army Engineers 1956).

South Slope

Snowmelt rates were consistently greater in the recovery plot for the six measurement periods (table 2). The lack of sampling data precludes clear evidence regarding trend. Because reductions in peak W.E. did not appear, we might not expect measurable change in melt rate. The lack of trend (not statistically tested) appears borne out by the 1974 data point, plotted within the 90 percent confidence band (fig. 7).

SUMMARY AND CONCLUSIONS

A study of the changes in snow accumulation and melt following timber harvest was conducted in a young mature-mature stand of cedar-hemlock-white pine in north Idaho. On the steep north slope, the immediate response to clearcutting was a 56 percent increase in peak snow W.E., most of which was associated with savings from interception loss. This pattern persisted until the new stand became established. After 26 years, a thinning of the untouched sapling stand reduced stems from 3,320 to 400 per acre (1,344 to 162 stems per hectare). Thirty-four years after clearcutting, a downward trend in peak snow W.E. was evident, although the overall increase remained a substantial 37 percent.

Based on the current trend, the gains will probably continue to diminish until the next thinning, scheduled for 1985. Reduction in crown-cover density at that time should reverse the trend and bring about a brief upswing in snow W.E. gain. The sequential pattern of decline followed by brief rise should be repeated, though in declining magnitude, at the time of commercial thinning in 2005 and again in 2045. By the end of the 100-year rotation, the managed stand should be accumulating more snow than an unmanaged stand of comparable age.

On the steep south slope, clearcutting resulted in a smaller peak snow W.E. increase of 37 percent. This average gain persisted after 34 years--even though the new stand was being slowly established. The silviculture plan called for no thinning, and unless the stand is thinned in the foreseeable future the gains will eventually decline.

Spring snowmelt rates were accelerated after clearcutting on the north and south slopes by 45 percent and 44 percent, respectively. After thinning the new north slope stand, melt rates declined over the years as crown-cover density increased the amount of shade. By the end of the evaluation period, melt rates were fully recovered and in fact were slightly less than those in the residual mature timber. Based on findings of other research we conclude that the minimum melt rate has been nearly reached in the sapling stand and will gradually *increase* as the crown-cover density approaches 1.00. The low melt rates provide the advantage of delayed snow disappearance, and should delay infiltration and subsurface flow to the stream channel at the time when bank-full volumes would be hazardous to channel stability.

On the south slope, the progress of stand reestablishment (unthinned) was proceeding slowly because of brush competition. Reduction of the high melt rate was not detected. Maintaining a pattern of accelerated melt rate is desirable in south slope clearcuts. First, it represents a practical hydrologic method for rushing melt water out of the system before high flows of other subdrainages in the watershed collect and contribute to the peak runoff. Second, the early disappearance of snow from south slope openings exposes browse forage sooner and at a time when most needed by big game.

PUBLICATIONS CITED

Anderson, H. W.
1969. Snowpack management. *In* Snow, p. 27-40. Oregon State Univ., Water Resour. Inst., Seminar WR 011.69.

Cline, R. G., H. F. Haupt, and G. S. Campbell.
1977. Potential water yield response following clearcut harvesting on north and south slopes in northern Idaho. USDA For. Serv. Res. Pap. INT-191, 16 p. Intermt. For. and Range Exp. Stn., Ogden, Utah.

Gary, H. L.
[In press.] Duration of the effect of harvesting on snow redistribution in lodgepole pine in Wyoming. USDA For. Serv. Res. Note RM-366, 8 p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.

Haupt, H. F.
1972. The release of water from forest snowpacks during winter. USDA For. Serv. Res. Pap. INT-114, 17 p. Intermt. For. and Range Exp. Stn., Ogden, Utah.

Haupt, H. F.
[In press.] Local climatic and hydrologic consequences of creating openings in old climax timber. USDA For. Serv. Res. Pap. INT-223, 43 p. Intermt. For. and Range Exp. Stn., Ogden, Utah.

Packer, P. E.
1971. Terrain and cover effects on snowmelt in a western white pine stand. For. Sci. 17:125-134.

Satterlund, D. R., and H. F. Haupt.
1970. The disposition of snow caught by conifer crowns. Water Resour. Res. 6:649-652.

Stone, E.
1973. The impact of timber harvest on soils and water, appendix M, p. 428-458. Reprinted from the Report of the President's Advisory on Timber and the Environment, April 1974. USDA For. Serv., Washington, D.C.

U.S. Army Engineers.
1956. Snow hydrology. 437 p. North Pac. Div., Corps of Engineers, U.S. Army, Portland, Oreg.

USDA Forest Service
1973. Forest hydrology, hydrologic effects of vegetation manipulation, Part II. USDA For. Serv., North. Reg., 232 p. Missoula, Mont.

Zeimer, R. R.
1964. Summer evapotranspiration trends as related to time after logging of forests in Sierra Nevada. J. Geophys. Res. 69:615-620.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1979—677-019/96 REG. 8

Haupt, Harold F.
1979. Effects of timber cutting and revegetation on snow accumulation and melt in north Idaho. USDA For. Serv. Res. Pap. INT-224, 14 p. Intermt. For. and Range Exp. Stn., Ogden, Utah 84401.

Clearcutting on north- and south-facing slopes in a young mature, mid-elevation stand of mixed conifers in north Idaho resulted in substantial snow storage gains.

KEYWORDS: snow accumulation, snowmelt, snowpack management, forest hydrology, coniferous forest

Haupt, Harold F.
1979. Effects of timber cutting and revegetation on snow accumulation and melt in north Idaho. USDA For. Serv. Res. Pap. INT-224, 14 p. Intermt. For. and Range Exp. Stn., Ogden, Utah 84401.

Clearcutting on north- and south-facing slopes in a young mature, mid-elevation stand of mixed conifers in north Idaho resulted in substantial snow storage gains.

KEYWORDS; snow accumulation, snowmelt, snowpack management, forest hydrology, coniferous forest

Headquarters for the Intermountain Forest and Range Experiment Station are in Ogden, Utah. Field programs and research work units are maintained in:

Billings, Montana
Boise, Idaho
Bozeman, Montana (in cooperation with Montana State University)
Logan, Utah (in cooperation with Utah State University)
Missoula, Montana (in cooperation with University of Montana)
Moscow, Idaho (in cooperation with the University of Idaho)
Provo, Utah (in cooperation with Brigham Young University)
Reno, Nevada (in cooperation with the University of Nevada)

NATIONAL AGRICULTURAL LIBRARY
1022966171